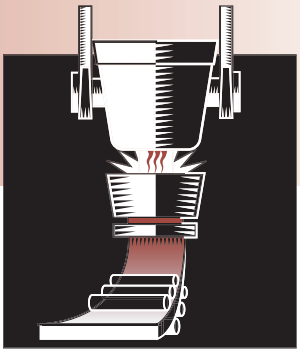
STEEL
Success Story



Energy-Efficient Process for Hot-Dip Batch Galvanizing

New Thermaprep® Process Saves Energy, Reduces Waste and is a Prerequisite to Lead-Free Galvanizing

Benefits

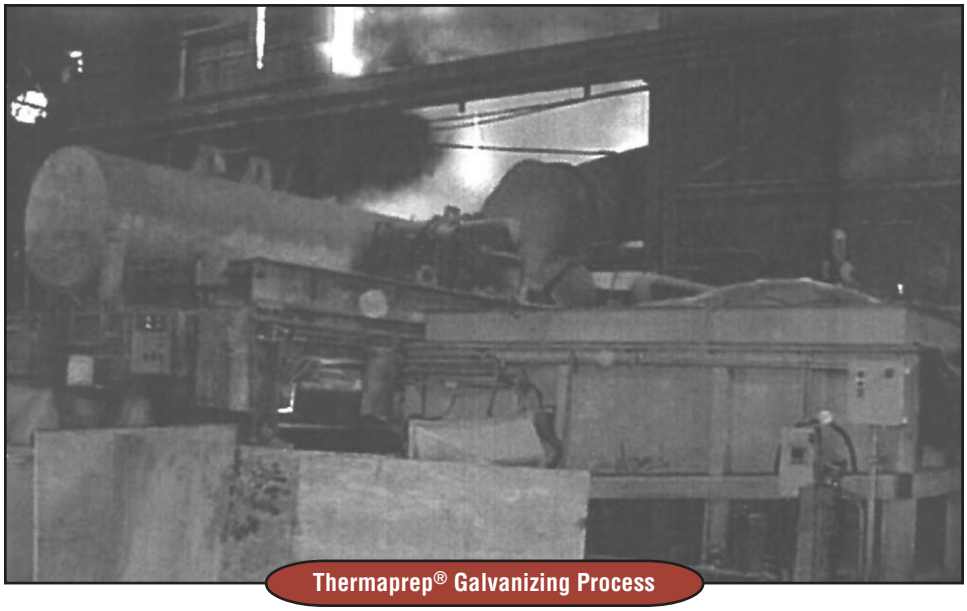
- Through 2000, the cumulative energy savings have been over 3.4 billion Btu
- Increases productivity by 15% to 20%
- Reduces dross and smoke generation
- Conserves zinc usage
- Increases expected kettle life span

Applications

Steel is a component in a wide range of products and is the building block for the construction, automotive, and machinery industries, as well as many others. Galvanizing steel products for corrosion protection is a popular practice that will increase with the development of this high-quality, energy-efficient coating process.

Hot-dip galvanizing is widely used to protect sheet steel, strip steel, pipes, and other structural and fabrication items from corrosion. In the traditional galvanizing process, steel parts are immersed into a kettle containing molten zinc and lead (about 1%) at about 850°F. The lead is used as a wetting agent. Once the surface of the steel parts reaches about 790°F, an intermetallic layer of iron and zinc starts to form. The parts remain in the kettle until the intermetallic layer is completely formed and adequate zinc thickness is achieved; the galvanizing process is then complete and the parts are removed.

The success of the galvanizing process is largely determined by dip time—the amount of time the part is required to reside in the kettle to reach the desired coating thickness. If the part requires a long dip time due to its large size or mass, the process will use more energy and the galvanized coating will often be thicker than necessary. Parts requiring long dip times also risk degradation of the flux layer that protects the part's surface from oxide formation. If the flux layer degrades, the result is a poorly galvanized part and increased waste generation in the form of dross and excessive smoke and ash.



Thermaprep® Galvanizing Process

OFFICE OF INDUSTRIAL TECHNOLOGIES
ENERGY EFFICIENCY AND RENEWABLE ENERGY • U.S. DEPARTMENT OF ENERGY

To solve these and other problems, Ferro Technologies, with support from the U.S. Department of Energy's NICE^3 (National Industrial Competitiveness through Energy, Environment, and Economics) Program, has developed the Thermaprep® process—an innovative batch galvanizing technology. The Thermaprep® process combines a new thermally stable flux solution and a preheat furnace to reduce energy use and increase batch galvanizing productivity while reducing waste generation.

"The NICE^3 project has demonstrated to Laclede: energy conservation, increased productivity and reduced cost of operation as benefits to the Thermaprep® technology."

– Jim Caporaletti
Vice President and
General Manager
Tubular Products/
Laclede Steel Company
St. Louis, MO

Technology Description

The traditional batch galvanizing process relies on several steps to ensure success:

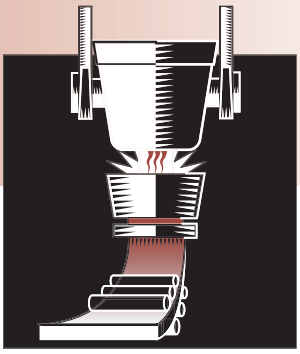
1. Steel surface cleaning – physically cleaning and degreasing steel parts.
2. Steel pickling – removing scale, rust, and oxide from steel parts.
3. Fluxing – applying a flux coating to reduce surface oxide and allow for the growth of a zinc-iron intermetallic layer necessary for proper galvanizing.
4. Drying – removing water from the flux layer.
5. Zinc immersion – dipping parts in the kettle containing molten zinc and lead.

The Thermaprep® process relies on the same basic steps as traditional batch galvanizing; however, this new process uses "thermal conditioning" to reduce dip times, increase energy efficiency, and minimize waste generation. The process begins with the same cleaning and pickling operations as traditional galvanizing. For the next step, fluxing, the Thermaprep® process uses a newly developed high-temperature flux that offers greater stability at higher temperatures. This new flux is a significant development because traditional fluxes degrade at the higher temperatures required by the Thermaprep® process and result in an inferior galvanizing process. Table 1 shows a comparison of traditional and high-temperature flux stability. Note that for each time increment, the Thermaprep® flux remains stable at a higher temperature. As a result, parts can now be preheated to a higher temperature without flux degradation.

OFFICE OF INDUSTRIAL TECHNOLOGIES

ENERGY EFFICIENCY AND
RENEWABLE ENERGY
U.S. DEPARTMENT OF ENERGY

STEEL
Success Story



Project Partners
- Ferro Technologies, Inc.
  Pittsburgh, PA
- LaClede Steel Company
  Alton, IL
- Pennsylvania Department of
  Environmental Protection
  Harrisburg, PA

The next step in the Thermaprep® process uses a separate furnace to preheat the parts at higher temperatures than the traditional process. The highly efficient furnace heats the parts from 400°F to 450°F or more before immersing them into the molten zinc. Because the parts are preheated in a separate furnace, the dip time in the kettle is greatly reduced to increase productivity. Significant energy savings are realized because the preheat furnace heats the parts more efficiently than the kettle.

Technology Benefits

The Thermaprep® process has several advantages over the traditional process:

- Preheating the parts reduces dip time, resulting in a 15% to 20% increase in productivity. The demonstration site increased productivity by 18%.
- Preheating the parts reduces the energy used to heat the kettle. The process becomes more efficient because the preheated furnace operates at about 60% efficiency while the kettle operates at 15% to 20% efficiency. The demonstration site reduced energy use by 29%.
- Using the high-temperature flux coupled with preheating reduces steel surface oxidation and dross (waste) generation.
- Reducing dip times allows better control of coating thickness, using 10% to 50% less zinc.
- Requiring less heat transfer through the kettle results in longer kettle life.
- Is a prerequisite to lead-free galvanizing.

Table 1. *Conventional and Thermaprep® Flux Stability*

Preheating Time *(minutes)*	Conventional Flux Stability Temperature *(°F)*	Thermaprep® Flux Stability Temperature *(°F)*
5	450	550
10	370	460
15	330	420

March 2002

Energy Savings and Pollution Prevention

As part of the NICE^3 program, the Thermaprep® equipment was demonstrated at the Laclede Steel plant in Alton, Illinois, where approximately 10,000 tons of galvanized product was produced in the demonstration. The results of the demonstration, shown in Table 2 were extrapolated over a 1-year period and are based on production of 60,000 tons of galvanized product per year.

The annual estimated environmental savings are 1,000 tons of CO_2, 2,394 pounds of NO_X, and 51.3 pounds of particulate and are based on the natural gas savings.

According to Jim Caporaletti, Vice President and General Manager of Laclede Steel Company, "The NICE^3 project has demonstrated to Laclede: energy conservation, increased productivity and reduced cost of operation as benefits to the Thermaprep® technology. Once new mechanical control of the pipe in the galvanizing kettle is implemented, further increase in these advantages is certain. Further, Ferrotech has proven that the Thermaprep® process is a key prerequisite in a successful lead-free operation."

Due to a parts-handling issue at the demonstration site, the full potential of the Thermaprep® process was not achieved; additional savings are anticipated with the installation of an optimized parts-handling system. Also, because the higher temperatures of the Thermaprep® process minimize the need for a wetting agent (i.e., lead) in the zinc, the technology is an important prerequisite for a lead-free coating process.

Table 2. *Natural Gas and Dross Savings from the Thermaprep® Process*

Resource	Conventional Process	Thermaprep® Process	Savings	Percent Savings
Natural Gas *(Btu/yr)*	58.3 x 10^9	41.2 x 10^9	17.1 x 10^9	29
Dross Generation *(tons/yr)*	360	240	120	33

NICE^3 – National Industrial Competitiveness through Energy, Environment, and Economics:
An innovative, cost-sharing program to promote energy efficiency, clean production, and economic competitiveness in industry.
This grant program provides funding to state and industry partnerships for projects that demonstrate advances in energy efficiency and clean production technologies. Awardees receive a one-time grant of up to $525,000. Grants fund up to 50% of total project cost for up to 3 years.

For project information, contact:

Michael J. Doll
Ferro Technologies, Inc.
1125 William Pitt Way
Pittsburgh, PA 15238
Phone: (412) 826-3239
Fax: (412) 826-3247
ferrotec@ix.netcom.com

Home Page:
www.ferrotech.net

For more information about the NICE^3 Program, contact:

Lisa Barnett
Program Manager
NICE^3 Program
U.S. Department of Energy
1000 Independence Avenue SW
Washington, D.C. 20585-0121
Phone: (202) 586-2212
Fax: (202) 586-7114
lisa.barnett@ee.doe.gov

Visit our home page at
www.oit.doe.gov

Order # NICE^3 ST-1
March 2002